



Life Prediction Verification for a Ceramic Diesel Engine Valve



A. A. Wereszczak, M. K. Ferber, and T. P. Kirkland

Mechanical Characterization and Analysis Group

High Temperature Materials Laboratory

Oak Ridge National Laboratory, Oak Ridge, TN 37831-6069

Objectives

- Contribute to the development of life prediction algorithms that can be used in the design of structural ceramic components for load-bearing applications.
- Independently verify the capabilities of life prediction codes whose development was sponsored by DOE/OTT/CTP programs at AlliedSignal Engines and Allison Engine Company.
- Use prototype ceramic engine components as *model* components for exercises that assess the capabilities of these codes.
- Provide mechanical testing and analysis (with DOE/OTT/CTP's program at the University of Dayton Research Institute) in support of the development of a candidate commercial silicon nitride material for advanced heat engine components (supports DOE/OTT/CTP's ACMT program at Saint-Gobain/Norton Industrial Ceramics).

Approach

- Utilize the life prediction codes to predict the mechanical performance of a ceramic engine component, and then compare to actual experimental or service performance.
- The algorithm consists of the following:
 - Generate a strength and fatigue database for the structural ceramic material that the component is made from. After fractography, determine censored Weibull and scaling parameters.
 - Perform finite element analysis (FEA) for the service thermomechanical state of the component.
 - Use the results from FEA, and the scaled Weibull parameters, as input into the life prediction codes to predict service mechanical performance.
 - Lastly, compare predicted with service mechanical performance.
- Use diesel exhaust valves made from commercially-available SiAlON and silicon nitride ceramics as the *model* component.
- Assess the mechanical character of the candidate SiAlON and silicon nitride materials as diesel exhaust valves.
- Ultimately, assess the capabilities of the examined life prediction codes and suggest enhancements where necessary.

Accomplishments During FY96:

- The sensitivity of machining parameters on the fast-fracture Weibull statistics and failure modes of NT451 SiAlON was examined.
- The fast-fracture mechanical performance of NT451 SiAlON diesel exhaust valves was predicted using AlliedSignal's life prediction codes, and compared with fast-fractured NT451 SiAlON valve results.
- The life prediction algorithm using AlliedSignal's codes was found to yield a good correlation between predicted and experimental mechanical performance of NT451 SiAlON exhaust valves.